improvement and does not, of itself, introduce another toxicity factor.

The nitrite-thiosulphate combination was definitely more effective with sheep than with cattle.

Doses of sodium nitrite above 95 mg. per kg. are likely to be fatal and above 50 mg. per kg. are dangerous. The safest therapeutic dose that can be recommended for cyanide poisoning is 1 g. intraperitoneally for a 75 to 90 pound (35 to 40 kg.) sheep and 2 g. is the largest dose that should be given.

PALEONTOLOGY.—Celliforma spirifer, *the fossil larval chambers of mining bees.*[1] ROLAND W. BROWN, U. S. Geological Survey. (Communicated by JOHN B. REESIDE, JR.)

The 1930 Smithsonian expedition, led by C. W. Gilmore to the Bridger Basin in southwestern Wyoming, brought back to the National Museum among its collection of fossils a handful of curious, solid objects (Fig. 3) that have remained unidentified. These specimens were found by George B. Pierce in surface material weathered from the lower strata of the fresh-water Bridger formation of upper Eocene age, about 6 miles southeast of Mountainview, Wyo., in sec. 18, T. 14 N., R. 14 W.

The natural size sketch (Fig. 3) illustrates several of the more perfect specimens. They average 2.7 centimeters in length by 1.2 centimeters in diameter. They are greenish gray to white in color, smooth, and round; but many are slightly flattened and bent like a bean; most show the effects of former breakage and partial collapse and now superficially resemble cracked but not disintegrated eggshells. The apex is a low dextral spiral of four or five turns making an inconspicuously scalloped and pitted groove. In some examples the apex is an almost flat spiral, in others the last turns form a narrow prominent blunt point.

Numerous sections disclosed no internal cellular structure or organic remains of any kind. The matrix of the unbroken specimens is calcite; that of the more or less broken specimens is calcite and greenish clay. It is clear that the calcite crystallized in a cavity, sometimes filling the cavity completely, sometimes leaving empty pockets to be filled or not with clay.

Speculation about these objects ranged from snake eggs to date seeds, on which latter probability they were referred to me for identification. A search of the literature and the seed collections, however,

[1] Published by permission of the Director, U. S. Geological Survey. Received October 30, 1934.

failed to develop any definite clues suggesting relationship to plants. Turning to animal fossils, I found that Scudder[2] had described and figured a mass of insect eggs under the name *Corydalites fecundum*. These eggs are minute, 2.6 millimeters long by 0.6 millimeter wide but, when enlarged to a size comparable with the Wyoming specimens, become somewhat like them. Nevertheless, the large size of the Wyoming specimens, it seems to me, effectively precludes their having been insect eggs.

The specimens compare best with material described and figured by Dall[3] from the "silex beds" of the Tampa formation (now regarded as of lower Miocene age) at Ballast Point, Tampa Bay, Fla. According to Dall, his Figure 4, Plate 24, which is almost identical with some Wyoming specimens, represents the burrow of a fossil limestone-boring bivalve mollusk, *Lithophaga nuda* Dall (his Fig. 7, Pl. 26). After an examination of these types and all the similar material in the National Museum collections from the "silex beds," I am of the opinion that a few may be molds of *Lithophaga* burrows; but with respect to those having the characteristic spiral apex, I demur. *Lithophaga* has no operculum, does not close its burrow, and possesses no other mechanism that would account for the origin of the spiral in the fossils.

There seems to be no question that the Wyoming and Florida specimens represent relics of the same type of organism, though the species may well be different, but not at present definitely separable. The Florida specimens (Fig. 1) differ from the Wyoming specimens chiefly as follows: They are composed of chalcedony and may be solid or partially solid with free water in the unfilled space, visible when the specimen is handled. They are somewhat shorter and stouter, and the apical spire in most cases is narrower and longer. They are found in sediments that were deposited in the marine or brackish water of an estuary or bay. These differences in structure, composition, and occurrence, fortunately for the argument, are not mutually exclusive and fatal, when it is remembered that the fauna of the "silex beds," besides some 300 marine and brackish-water mollusks, also includes 24 species of land and fresh-water shells.[4] Evidently land was close to the site of deposition of these beds. It seems

[2] Scudder, S. H. *The Tertiary insects of North America.* U. S. Geol. Survey Terr. Rept. **13**: 139–153, *pl. 4, figs. 5–7, 13–16, 18–21, 23.* 1890.

[3] Dall, W. H. *A monograph of the molluscan fauna of the Orthaulax pugnax zone of the Oligocene of Tampa, Fla.* U. S. Nat. Mus. Bull. **90**: 129, *pl. 24, fig. 4*; *pl. 26, fig. 7.* 1915.

[4] Cooke, C. Wythe, and Mossom, Stuart. *Geology of Florida.* Florida Geol. Survey Ann. Rept. **20**: 82. 1929.

therefore that any explanation that presumes to account for the ultimate origin of these objects in one case must apply, perhaps with some slight modification, to the other also.

No identification seeming acceptable at the time, these specimens were temporarily set aside and did not claim attention again until August 27 of this year (1934). On that day geological field work brought me to a locality one-half mile up Cove Creek from its mouth on the Weiser River, 9 miles east of Weiser, Idaho. There, on the

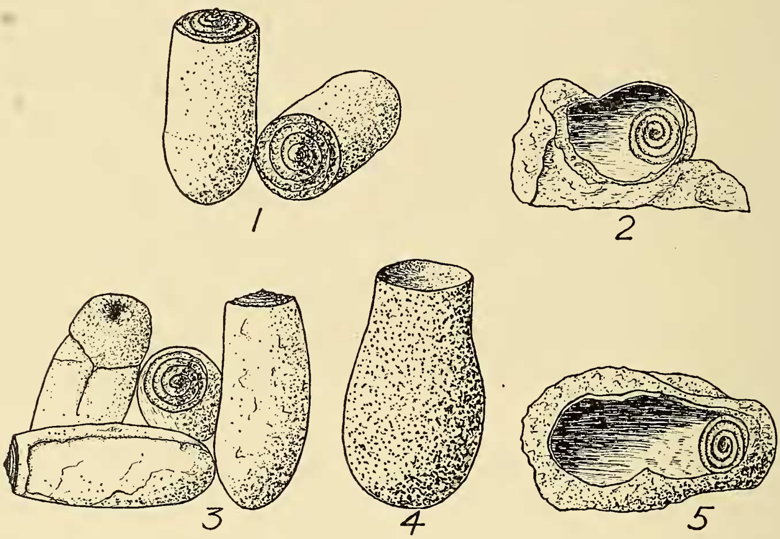

Fig. 1.—Lower Miocene fossil molds from the "silex beds" of the Tampa limestone, Tampa Bay, Fla. Fig. 2.—Apical interior of the larval chamber of *Entechnia taurea* (Say) Patton. Fig. 3.—Upper Eocene fossil molds from Mountainview, Wyo. The left upright specimen retains a portion of the chamber and seal. Fig. 4.—Sandy larval chamber of a living bee from a cliff near Weiser, Idaho. Fig. 5.—Interior of the larval chamber of *Emphor fuscojubatus* Cockerell. The spiral is the reverse of that in Fig. 2. All figures natural size.

east side of an irrigation ditch, I found an exposure of soft sandstone the face of which was riddled with small holes, a centimeter or less in diameter. When excavated, these proved to be the entrances to the burrows leading to the larval chambers of a living species of mining bee, presumably an anthophorid. The chambers were well-formed with thin walls of fine sand held together by a dark brown cement. Some were empty, some were filled with sand and other debris, but a few were sealed and apparently perfect (Fig. 4). They contained, however, only small masses of pollen and remnants of pupa cases, principally of dermestid beetles. Further search did not produce an unmolested, loaded chamber, so that the exact identity of the builder remains unknown. The opened chambers, though disappointing in contents, nevertheless revealed some startlingly arresting characters. These were the size, shape, and smoothness of the interiors and the faint spiral mark on the inside of the seal. Could such interiors have been the molds from which nature by geological processes cast the problematic objects brought back from Wyoming by the Smithsonian expedition?

On my return to the Capital I sought the advice and assistance of entomologists working at the U. S. National Museum, in particular, R. A. Cushman, J. C. Bridwell, and Grace A. Sandhouse, who searched their collections and produced, among others, the larval chamber of an anthophorid bee, *Emphor fuscojubatus* Cockerell (perhaps a form of *Emphor bombiformis* Cresson), collected at Chesapeake Beach, Md., by Bridwell in 1920. The apical interior of this specimen (Fig. 5) and that of a chamber of *Entechnia taurea* (Say) Patton, collected by Bridwell and the writer in an abandoned clay pit near Arlington, Va., October 27, 1934, show the spiral feature of the seal very clearly. These spirals are counterparts of those on the fossils in that instead of having grooved turns they have turns whose surface is convex toward the interior of the chamber. Examination of the abundant material of *Entechnia taurea* from Arlington indicates that the spirals of the chambers containing well-developed healthy larvae are almost always faint or completely obliterated; but that those in cells which were not provisioned or that proved to be "duds" for one reason or another, are usually sharply defined.

Since the sealing of the chamber is an operation performed in the privacy and semi-darkness of an underground burrow, there is some excuse for the lack of precise recorded observations on the process. A few papers[5] get close to it, but so far I have found only one publication[6] that figures the inside of the seal and speculates upon the technique of its construction. Wesenberg-Lund, however, pictures the inside of the seal (his Fig. 4, Pl. 2) made by *Anthophora parietina* Fabricius as showing concentric circles about a small hole through which, he says, the bee thrust her tongue and coated the surface with

[5] GROSSBECK, J. A. *A contribution toward the life history of Emphor bombiformis Cresson.* N. Y. Entomol. Soc. Jour. **19**: 238–244. 1911.

NICHOLS, N. LOUISE. *Some observations on the nesting habits of the mining bee, Emphor fuscojubatus Cockerell.* Psyche **20**: 107–112. 1913.

BISCHOFF, H. *Biologie der Hymenopteren.* Biologische Studienbücher **5**: 229–230. 1927.

RAU, PHIL. *The nesting habits of Emphor bombiformis Cresson.* Brooklyn Entomol. Soc. Bull. **25**: 28–34. *figs. 1–5.* 1930.

[6] WESENBERG-LUND, C. *Traek af Linnes vaegge-bi's (Anthophora parietina Fabr.) biologi og anatomi.* Entomolgiske Medelelser (Copenhagen) **2**: 97–120, *pl. 2.* 1889–90.

a limy substance. I have not seen chambers of *A. parietina*, but those of *A. abrupta* Say, a related species, do not suggest confirmation of all Wesenberg-Lund's conclusions. The cells of this species are lined with a thin white coating, but it does not react with either hydrochloric or acetic acid, the latter being the reagent used by Wesenberg-Lund. The minute hole may or may not be present, as is also the case with *Entechnia taurea*, but the marks around it are the turns of a spiral and not of concentric circles. Bischoff, cited above, also records spirals in the genus *Tetralonia*. Lack of further adequate material prevents an authoritative statement at this time as to how widespread is the occurrence of the spiral seal among the mining bees, or whether some species make more conspicuous spirals than others.

The existence of suggestive living forms from the predecessors of which the fossils may possibly have been derived, having been pointed out, it will now be necessary, since direct testimony is absent, to marshal the circumstantial evidence in support of the probability that the fossils may be the molds of the interiors of the larval chambers of a hymenopteron. It is not my intention to tie the fossils to any particular living genus and species, but rather to suggest that the relations between the two phenomena are those of biologic affinity and not merely of striking analogy.

The size and shape of the fossils with their spiral apices conform to the interiors of the larval chambers of some anthophorid bees. In these characters the bee chambers vary considerably. Some are long, of medium width, and more or less slightly bent; others are short, stout, and straight. Some are constricted rather sharply at the apex; others are more wide-mouthed. The spirals of the seal are sometimes perfect, sometimes crude, or perhaps absent altogether. They may be high, low, or even depressed, that is, with the apex directed toward the interior of the chamber. All these features and their variations find counterparts in the fossils. In some instances the fossils have irregular deposits of clay on their surfaces that apparently represent portions of the wall and neck of the larval chambers in which they were formed.

In conjunction with the characters already mentioned, the smoothness of the fossil surfaces may be offered as additional corroborative evidence. These smooth surfaces are the kind one would expect to find on fossils derived from the polished interiors of bee chambers by the infiltration of mineral substances. This smoothness suggests that the fossils originated from bee rather than from wasp chambers, because, according to well-authenticated observations, many digger wasps that store their larval chambers with animal prey, build rough, unfinished chambers and do not seal them with a cemented plug but merely kick sand and soil into a compact heap at the mouth of the cell and continue thus to fill up the burrow to the exit at the surface of the ground. On the other hand, the colonial mining bees that gather nectar and pollen, polish and veneer their chambers, leaving the surfaces smooth and, for a time, relatively impervious. This procedure is apparently necessary to prevent leakage from the interior and damage from the exterior during the filling of the cell and the development of the larva as it feeds upon the stored liquid or semiliquid provisions.

It may be objected, as an alternative explanation, that the spiral apex of the fossils means relationship to a snail. This suggestion, however, cannot be entertained because the spiral is the only snail characteristic present in the fossils. The shell of no gastropod mollusk of land, fresh water, or marine type fits either the form or the locality requirements of these fossils.

Can a sequence of circumstances be imagined that would explain the origin of these fossils from bee chambers without doing violence to geologic principles? A satisfactory reply to this question must obviously first account for the absence of actual insect remains in the fossils. Since limestone strata in many parts of the world are noted for their rich fossil contents, why should these calcite molds not preserve the pupal skins or other parts of the former inhabitants of the chambers? The explanation is empirical. The purer fossiliferous limestone strata rarely, if ever, preserve the softer, phosphatic portions of organisms but do preserve such hard parts as shells and bones, or their impressions, from which most or all the phosphates have been leached and been replaced by calcium carbonate. It is therefore not surprising, at least to a paleontologist, to find no insect remains in these almost pure calcite molds.[7]

The geologic method by which these molds originated is that illustrated by the formation of those geodes that are the result of cavity fillings. It was necessary that a fortunate geologic incident cause the bee chambers to be bathed for a time in waters charged with calcium carbonate or bicarbonate, so that those infiltrating solutions could fill the cavities. Since the exact source-bed from which the Wyoming fossils were weathered is not definitely known, it seems almost idle to speculate on the precise nature of the geologic incident or series of

[7] See discussion of chitin in PACKARD, A. S. *A textbook of entomology*, p. 29, 1898.

incidents that caused the influx of lime waters to the area of the bee chambers. Was it faulting, land-slipping, subsidence, climatic change, collapse of a sink, or some other event that brought the chambers within the influence of such waters and permitted the infiltration and precipitation of calcium carbonate? The habitats of living anthophorid bees are varied and it is not inconceivable or unreasonable that in the relatively long course of Tertiary history a few favorable accidents should have resulted in the production of fossils from bee chambers.

The Florida specimens from the "silex beds" present an interesting variation on this theme in that they are composed of chalcedony instead of calcite. It is my opinion that the bee chambers here concerned were originally located in a sea-cliff, stream bank, or elevated mud flat near the coast. Weathering out of the cliff and falling into the water, or with subsidence of the area, they were buried together with marine and fresh-water debris, the whole forming what is now known as the Tampa limestone. It is quite possible that calcite first filled the unbroken chambers, but that later, with elevation of the strata above sea level, it was replaced by silica, an exchange that seems even now in progress among the fossils in the upper layers of the formation.

Since entomologists agree that the history of the solitary bees and wasps extends backward at least to the Eocene, if not to the Cretaceous, there need be no objection on the score of geologic age to the idea that these fossils may represent objects associated with the life cycle of those Hymenoptera. The present geographic distribution of the anthophorid bees is amply sufficient to include occurrences in Wyoming and Florida, and by inference I judge that some species may have been as widely distributed in upper Eocene and lower Miocene time. I have not seen the photographs or specimens reported by Buxton[8] of supposed bee chambers taken from a cave in Palestine. They were, however, associated with remains of ancient man and are, therefore, apparently of late geologic age.

If the identification of these fossils as stated here is correct, the unbroken specimens with seal intact suggest, in effect, tragic incidents of the insect world of 30 million years ago. Then, as now, on account of parasitism and other causes, many bee larvae never matured to break the seals of their earthen chambers and to emerge as adults. The fossil molds are the only records of their frustrated lives.

[8] Buxton, P. A. *Ancient workings of insects, perhaps bees, from Megiddo, Palestine.* Entomol. Soc. London Proc. 7: pt. 1: 2–4. 1932.

For the purpose of convenient reference I have deemed it wise to name these fossils but without implying identity with any living species of bee. The name, *Celliforma spirifer*, is designed to mean "the spiral-bearing form of a cell."

PALEONTOLOGY.—*Land shells from the Upper Eocene Sespe deposits, California.*[1] G. DALLAS HANNA, California Academy of Sciences. (Communicated by JOHN B. REESIDE, JR.)

Fossil land shells have been found so seldom in the older Tertiary sedimentary rocks of California that the small collection of specimens, submitted to me by Dr. Chester Stock, seems well worthy of record. The shells were found in the course of quarrying operations for fossil vertebrates in the Sespe deposits and are preserved in a dark red and green matrix, so characteristic of the Sespe in general. All of the specimens are more or less imperfect. An association with fossil mammalian remains in the stratum in which they occurred, places their age as upper Eocene.[2] This type may be described as follows:

Helminthoglypta? stocki Hanna, n. sp.
Figures 1 to 3a

Shell large, globose, narrowly umbilicate; whorls about $6\frac{1}{2}$ to 7, sutures moderately impressed; aperture and peristome not preserved, but apparently these are not expanded; shell extremely thin and sculptured only with delicate evenly developed growth lines.

MEASUREMENTS

	Altitude	Diameter
Holotype	32 mm.	38.5 (Slightly immature)
Paratype	27.5	41 (Crushed)
Paratype	26.5	36.5 (Immature)

Holotype, No. 3244, and two paratypes, Nos. 3245, 3246, from the upper Eocene Sespe deposits, north of the Simi Valley, Ventura County, California. Field Locality 180 Calif. Inst. Tech. Vert. Pal. Shells in the invertebrate collections of the California Institute.

The essential characters for diagnosis of the species in *Helminthoglypta* are apparent. The moderately elevated spire and generally globose shape are features found in no other west American species. In these characters the Sespe shells resemble "*Helix*" *leidyi* Hall and Meek[3] from the Oligocene White River Group of the eastern slope of the Rocky Mountains. That species, however, is usually smaller and somewhat more globose, according

[1] Received November 8, 1934.
[2] Stock, C. Proc. Nat. Acad. Sci. **20**: 150–154; 349–354. 1934.
[3] HALL, J. and MEEK, F. B. Mem. Amer. Acad. Arts and Sci., n.s. **5**: 394, *pl. 3, fig. 12.* 1854. This species was placed in the new genus *Pseudolisinoe* by Wenz (Foss. Cat. pt. 18, no. **2**: 365. 1923), the type being *Helix veterna* Meek and Hayden.